

# Corning Fibers, Amplifiers, and Functional Components for keeping Data in the Optical Domain

DARPA Workshop on Data in the Optical Domain  
18 March 2003

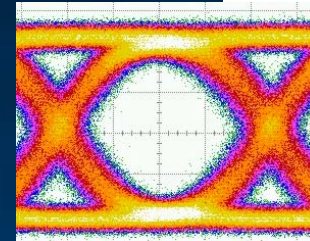
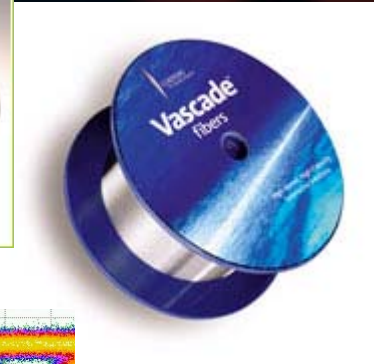
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**CORNING**  
*Discovering Beyond Imagination*

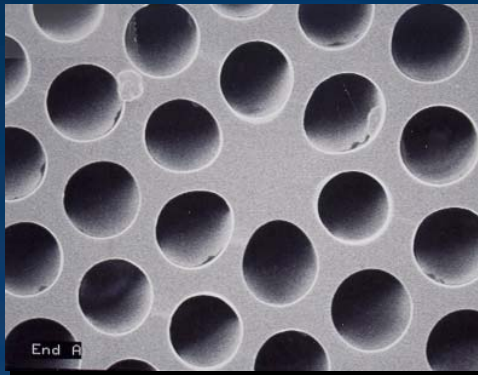
# Corning Leads Today

- World's leading producer of
  - optical fiber and cable
  - optical amplifiers and pumps
  - high performance optical modulators
- State of the art optical layer modeling and simulation
- Research in technologies needed for Data in Optical Domain
  - Advanced transmission and component fibers
  - Broadband dynamic impairment compensation
  - Integrated InP / InGaAsP devices
  - All optical regeneration
  - All optical switching and signal processing

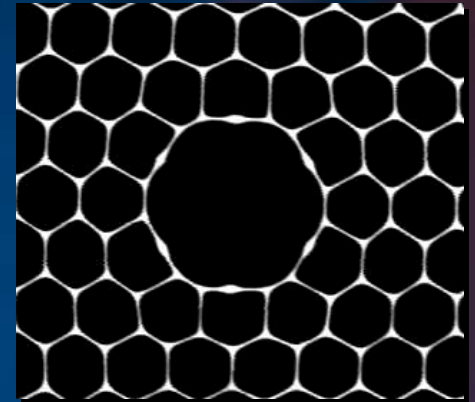


# Advanced Fibers: Dispersion Managed, Single Polarization Nonlinear, Photonic Crystal and Photonic Band-Gap Fibers

- Target application requires advanced fibers
- Corning is a leader both in advanced
  - transmission fibers
  - component fibers



- Solid-Core
  - Small  $A_{\text{eff}} < 4 \mu\text{m}^2$
  - Losses,  $\alpha \sim 1 \text{ dB/km}$
  - Dopant-free profile
  - Unique dispersion properties



- Hollow-Core
  - Ultra-linear fiber
  - High index contrast
  - Intrinsically low loss

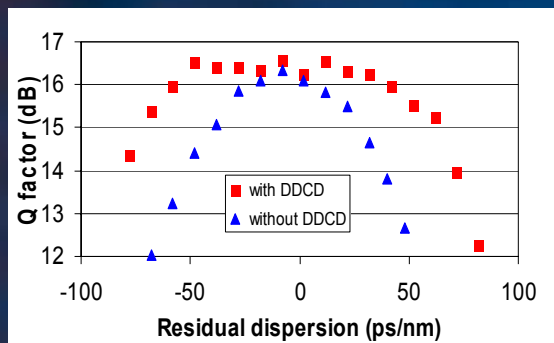
# Fiber-based Dynamic Compensation

## Fiber-based Optical Regeneration

- Target requires dynamic compensation/optical regeneration.
- Corning has demonstrated broadband high data rate
  - all-optical dynamic dispersion compensation
  - all-optical regeneration

### All-optical broadband dynamic dispersion compensator

Signal Q-factor vs residual dispersion

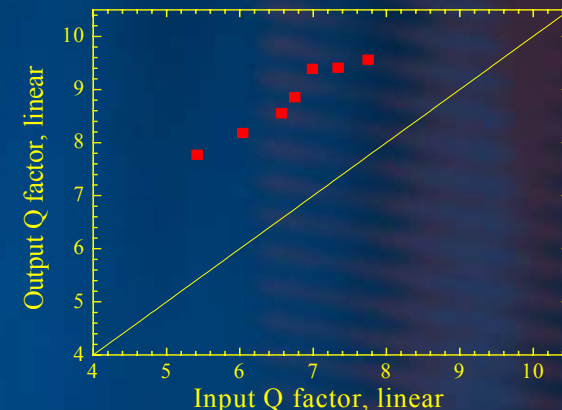


Research prototype



### All-optical regenerator

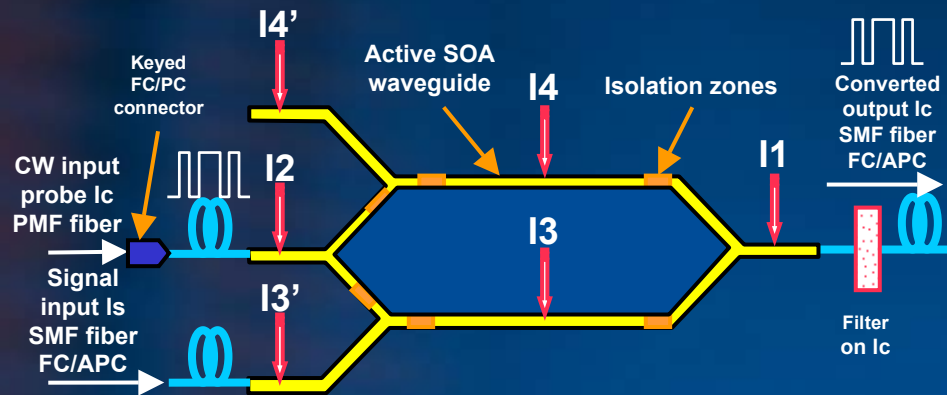
Performance  
(output Q vs Input Q)





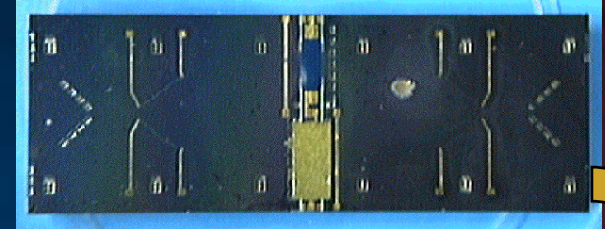
# Integration Technologies for all-optical 2R and 3R regeneration

- Passively aligned hybrid integration
- Re-amplify, Re-shape, Re-time
- 40Gb/s 2R & 3R demonstrated
- Wavelength conversion (11 nm)
- Arrays for multichannel operation
- Technology for optical clock recovery

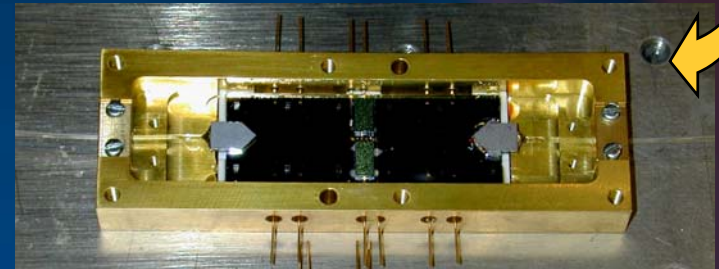


Ref. ECOC PD3.5 "Very low coupling loss, hybrid-integrated all-optical regenerator with passive assembly"

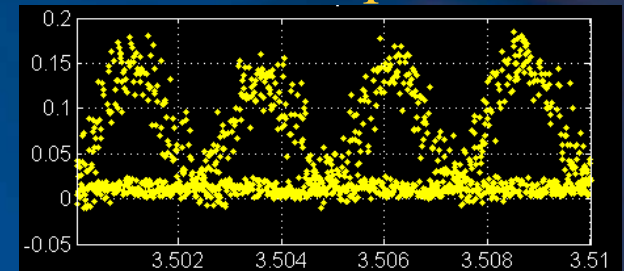
## Hybrid Optical Subassembly



## Packaged Device



## 2R Output



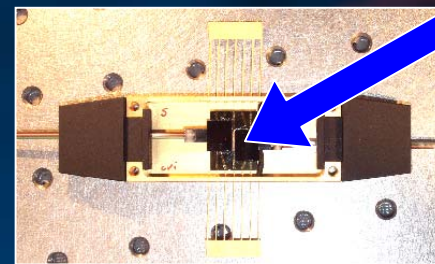
# High Performance Linear SOAs and SOA arrays in passively aligned optical subassemblies

- Linear SOAs
  - Record High  $P_{\text{sat}}$  (>17 dBm)
  - Record Low NF (6 dB)
- Low impairment
  - 8 channels 40G: Q>18.5 dB
- 8x8 integrated switches demonstrated
- Fast switching time (<1ns)
- Integratable
  - ultra-compact
  - hybrid and monolithic

Discrete Linear SOA



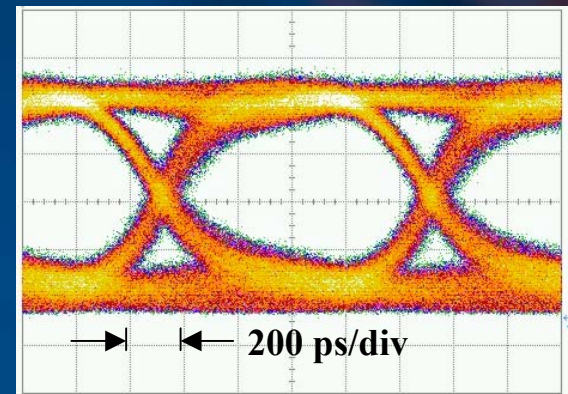
Passively-aligned SOA array hybrid assembly



Octal SOA array

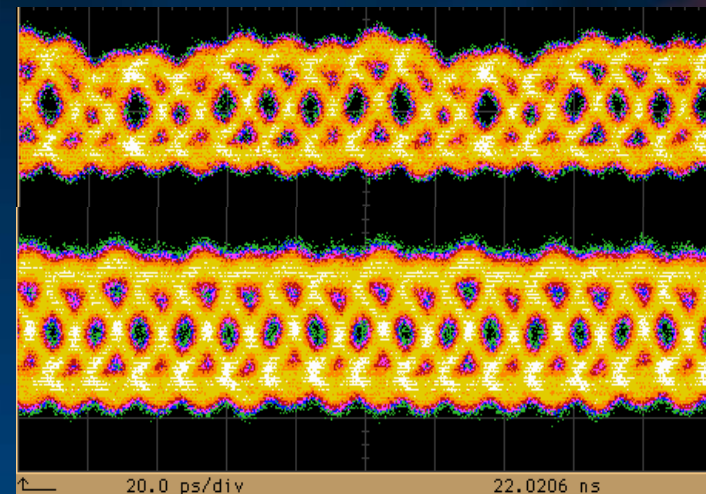
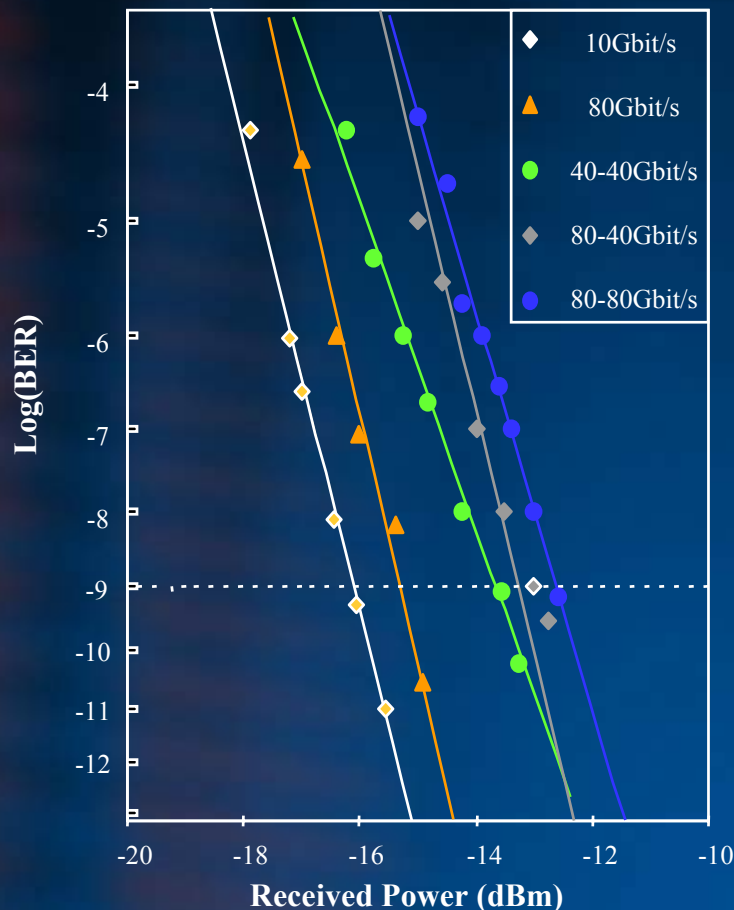


$2^{31}-1$  PRBS Large Signal Switching Response



# All optical 80Gbit/s SOA Switch

- Polarisation diversity Mach Zehnder interferometer (UNI)

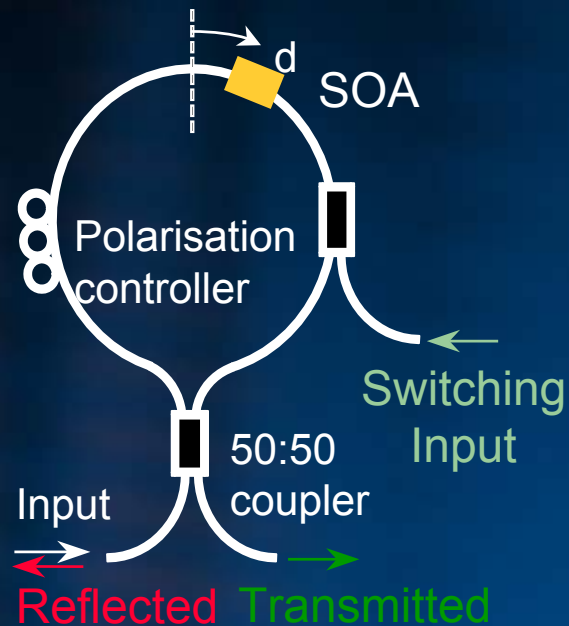


9.1dBm pump power  
5.15dBm probe power

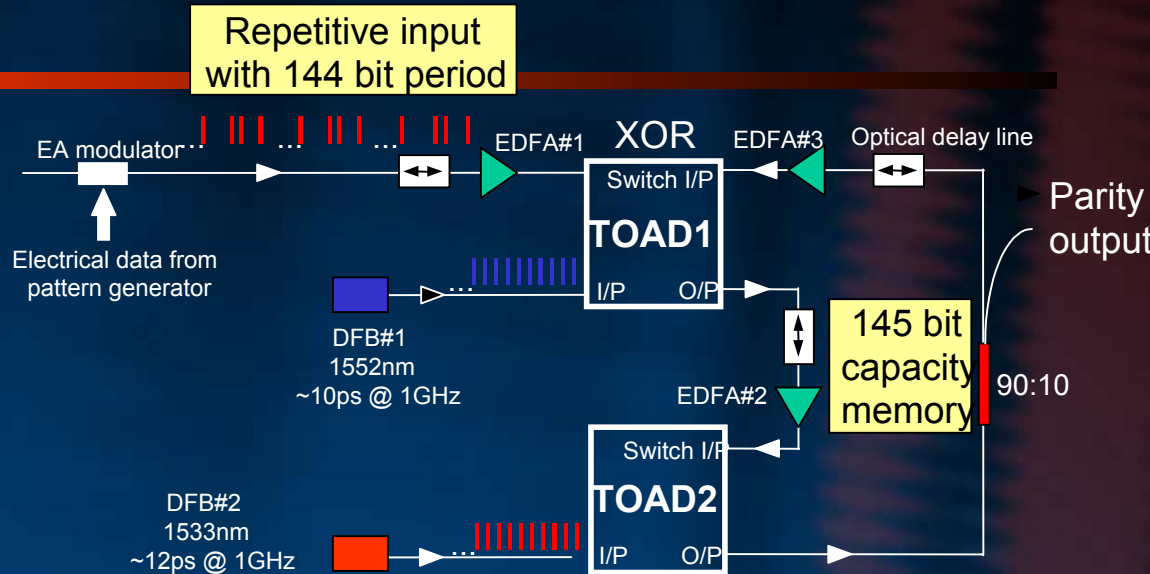
Switching energy of  
~200fJ @ 80Gbit/s



# All-optical Parity Checking using Sagnac Loop Mirror (TOAD)

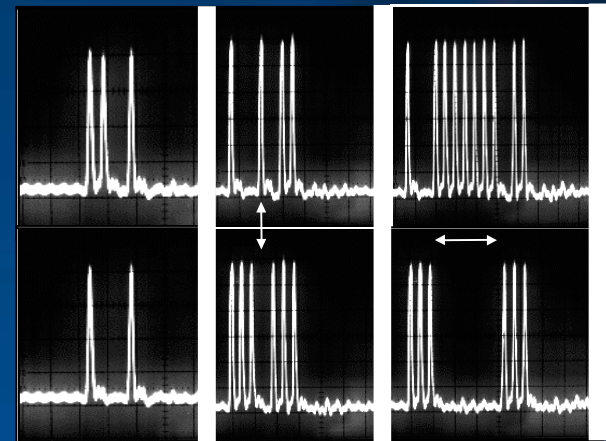


- Parity bit(s) can be read-out using third TOAD in memory



Odd parity

Even parity



Input word  
(4 bit)

Parity output  
(Input 4X)

Parity output  
(Input 10X)

CORNING



# Summary

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- Corning continues its commitment to technical leadership and innovation in the optical layer
- We have committed already to bringing fast multichannel dynamic optical interconnection technologies to optical packet switched systems at data rates of 40G and above.
- Our competencies in HDR fiber transport, amplifiers, III-V photonics, static and dynamic impairment management and hybrid and monolithic integration will be applied to future optical packet systems.
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